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ABSTRACT

This paper reviews research on school effects and teacher effects on student achievement. In general, academic learning is influenced by the amount of time that students spend engaged in appropriate academic activities. Students learn more efficiently when their teachers instruct them actively by structuring new information and helping them relate it to what they already know, and then monitoring their performance and providing corrective feedback through recitation, drill, practice, and application activities. Schools that foster progress in academic achievement tend to be those that place a high priority on achieving and adopt high but realistic expectations, coordinated instructional efforts, and periodic assessments of progress. Elements that lead to success in the traditional whole-class instruction approach are discussed at length. Adaptations of those elements for grade level, subject matter, and student socioeconomic status/ability/affect are pointed out. Research on the following topics is also discussed: (1) conceptual change teaching; (2) teaching cognitive strategies; (3) mastery learning; (4) individualized/adaptive instruction; (5) computerized instruction; and (6) effective instruction in special education and resource room situations. An extensive list of references is included. (PS)

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# RESEARCH LINKING TEACHER BEHAVIOR TO STUDENT ACHIEVEMENT: POTENTIAL IMPLICATIONS FOR INSTRUCTION OF CHAPTER 1 STUDENTS

by

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RESEARCH LINKING TEACHER BEHAVIOR TO STUDENT ACHIEVEMENT:
POTENTIAL IMPLICATIONS FOR INSTRUCTION OF CHAPTER 1 STUDENTS

This paper reviews research on school effects and teacher effects on student achievement. Most of this research was conducted in regular classroom settings rather than in special classes set up to deliver compensatory instruction to Chapter 1 students, but it is believed to be relevant input informing policy decisions about compensatory education, for four reasons. First, reviewers of research on compensatory and special education (Leinhardt & Pallay, 1982; Madden & Slavin, 1983) have concluded that the settings in which compensatory education take place are not nearly as important determinants of outcomes as the amount and nature of the instruction that occurs within those settings. Second, with the exception of a modest literature on specific learning disabilities, research has turned up very little evidence suggesting the need for qualitatively different forms of instruction for students who differ in aptitude, achievement level, socioeconomic status, ethnicity, or learning style. Main effects tend to be much more frequent and powerful than interactions, and the interactions that do occur tend to be ordinal interactions indicating that some students need more (of the same kind of) instruction rather than disordinal interactions indicating that some students need to be taught one way but other students need to be taught a different way (Brophy & Good, 1986; Cronbach & Snow, 1977; Doyle & Rutherford, 1984; Good & Stipek, 1983). Therefore, most findings concerning effective instruction of heterogeneous groups of students in regular classrooms will also apply to instruction of the same content to homogeneous groups of Chapter 1 students, whether in regular classrooms or in special settings. Third, much of the process-outcome research linking teacher behavior to student achievement focused on instruction in basic skills in the elementary grades in Title I or Chapter 1 schools, even if it did not occur in resource rooms or other special compensatory educational settings. Fourth, some such research did take place in resource rooms and other special compensatory educational settings, and for the most part, the findings from these studies suggest the same patterns of relationship between teacher behavior and student achievement as do the findings from studies conducted in regular classroom settings (the few exceptions will be noted later in the present paper). Unless otherwise stated, then, the research findings and suggested policy implications reviewed here are believed to apply to the compensatory education of Chapter 1 students in either regular or special classroom settings.

To provide focus for the review, and to avoid unnecessary overlap with other reviews prepared for presentation at the conference, the scope of the present paper has been circum-

scribed in several respects. First, the review concentrates on the literature on instruction (how to teach) but not on the literature on curriculum (what to teach). Second, it concentrates on empirical research in classroom settings but not on theoretical models of the learning process or on instructional design research conducted in laboratory settings. Finally, it concentrates on research designed to develop knowledge about relatively general principles of classroom teaching rather than principles unique to instruction in particular subject matter areas. In considering potential policy implications of the research findings, heavy emphasis has been placed on realism and practicality. That is, rather than considering what might be accomplished under more ideal circumstances, the emphasis is on what probably can be accomplished with the resources and within the constraints that apply in typical public school settings.

This emphasis on classroom teaching compliments the emphasis on curriculum goals and content typically found in reviews by discipline-based writers (see Calfee & Drum, 1986 on reading instruction and Romberg & Carpenter, 1986 on mathematics instruction). It takes as its point of departure the fact that teachers are charged with instructing classes rather than tutoring individuals. Consequently: (1) teachers must rely on methods that allow them to manage the students' behavior in addition to their learning; (2) they must either teach the whole class as a group or find ways to keep the rest of the class profitably occupied while working with small groups or individuals; (3) whatever the curriculum as intended by policy makers or materials designers, the curriculum as enacted in the classroom will be determined not only by the materials but by the explanations, demonstrations, and practice and application opportunities provided by the teacher; (4) the methods, materials, and activities that the teacher chooses to include in the total instructional program will be included at least in part because they are seen as compatible with one another and with successful classroom management; and (5) the total instructional program will be a compromise constructed in the belief that it will allow the teacher to meet more of the needs of more of the students than any of the feasible alternatives—it will not be an ideal program that continually meets each individual student's needs. The need to accept compromises by trading off classroom management benefits against costs in instructional quality and efficiency increases in relationship to the size and heterogeneity of the class. Large, heterogeneous classes require more regimentation to achieve a given level of management efficiency than smaller, more homogeneous classes do, and although it is possible for teachers to elicit comparable achievement gains from the former classes, doing so will require them to sustain extraordinary efforts and to minimize personal and social interactions with students, assignments that are desirable but time consuming to set up or

correct, and other "extras" that improve quality of life in classrooms for both teachers and students (Evertson, Sanford, & Emmer, 1981).

The compromise represented by traditional whole-class instruction/recitation/seatwork methods is the one that the majority of teachers have selected as their basic approach to classroom instruction. Consequently, most process-outcome research is based on natural variation within this traditional approach. Consequently, much of our review will refer to research conducted in traditionally taught classes, although research on innovations such as individualized or adaptive education will also be discussed. We begin with process-outcome research on school effects.

## Research on School Effects

Research that uses the school as the unit of analysis and seeks to establish linkages between school processes and student outcomes (especially achievement gain) is typically described as research on school effectiveness (if it involves "natural experiments" in which schools that attain impressive results are compared with schools that attain less impressive results from comparable student populations) or research on school improvement (in which guidelines developed from the "school effectiveness" research form the basis for inservice education programs whose effects on school processes or outcomes are then assessed). Such research is here described as research on school effects (rather than school effectiveness or school improvement) because a school's effectiveness in eliciting student achievement gain cannot be equated with the school's quality. School quality is a broader concept that usually would be defined to include not only achievement outcomes but affective outcomes such as promoting students' individual confidence and motivation as learners and their collective development of prosocial attitudes and cooperative behavior. The research reviewed here was focused on schools' effects on student achievement as measured by standardized achievement tests. This is valuable information that informs policy decisions, but it does not translate in any direct or automatic way into prescriptions for educational practice. In order to make such prescriptions, educational decision-makers must first identify and prioritize the educational outcomes that they value and then consider process-outcome information on the full range of outcomes to be pursued.

Although based on the same logic as teacher effects research (measure educational processes and outcomes, and then relate these two sets of measures), school effects research has been of generally lower quality. Process measures were usually

confined to interviews and high inference ratings, and if classroom observation was done at all, it was usually done for brief times in only a subset of the classrooms in each school. Also, the student populations attending contrasting schools were not always as well matched as the investigators would have preferred, and the measured effectiveness levels of schools have proven to be relatively unstable. Nevertheless, some school effects studies have been well designed (Brookover, Beady, Flood, Schweitzer, & Weisenbaker 1979; Rutter, Maugham, Mortimore, Ouston, & Smith, 1979; Teddlie, Stringfield, & Desselle, 1985), and in any case, reviews of this body of literature as a whole indicate broad agreement on a common set of findings (Borger, Lo, Oh, & Walberg, 1985; Good & Brophy, 1986; Purkey & Smith, 1983).

Compared to schools that elicit weaker achievement gains from comparable students, schools that elicit strong achievement gains tend to be higher on the following characteristics: (1) strong leadership (typically supplied by the principal) that produces consensus on goal priorities and commitment to instructional excellence; (2) a safe, orderly school climate that supports the role of the school as an environment for learning; (3) positive teacher attitudes toward students and positive expectations regarding the students' abilities to master the curriculum; (4) an emphasis on instruction, especially instruction in basic skills, in allocating classroom time and assigning tasks to students; (5) careful and frequent monitoring of progress toward goals through student testing and staff evaluation programs; (6) strong parent involvement programs designed to keep parents informed of the school's goals and policies and to enlist their assistance and participation; (7) consistent emphasis on the importance of academic achievement, including praise and public recognition (prominent display of the names of honor roll students, etc.) for students who excel academically.

In short, schools that foster progress in academic achievement tend to be schools that place a high priority on doing so and follow up by adopting high but realistic expectations, coordinated instructional efforts, and periodic assessments of progress. The school is established as an orderly, learning-oriented environment, and the teaching staff is encouraged to capitalize on this by maximizing the achievement gains of the students in their classes. Research on school effects is relatively silent about how teachers can accomplish this (except for emphasizing high expectations, allocation of classroom time to academic activities, praise and reward of academic progress, and cooperation with the families), but research on teacher effects provides a good deal of relevant information.

## Research on Teacher Effects

"Teacher effects" research refers to process-outcome research linking teacher behavior to student achievement. Like school effects research, it does not automatically translate into prescriptions for practice, but it provides useful information to inform the decisions of policy makers. The findings summarized here come from research conducted in typical elementary and secondary school settings, in which teachers were observed instructing their students under normal conditions. Product measures focused on achievement gain (controlled for entry level), and process measures were developed via reliable application of low inference coding systems by trained observers. Data were aggregated to focus on the teacher (or class) as the unit of analysis, and analyzed to identify the nature and strength of relationships between frequency or percentage measures of particular teacher behaviors and class means on adjusted achievement scores. Typically, the teacher behavior measures were summed or averaged across 4 to 20 observations spaced across time periods ranging from a few weeks to an entire term or school year, and achievement was measured with standardized tests administered at the end of the school year. Thus, these studies sought to link relatively general measures of teacher behavior with relatively general measures of student achievement. For more detailed review and discussion, see Brophy and Good (1986), Doyle (1986), and Rosenshine and Stevens (1986).

In the last 15 years or so, process-outcome research linking teacher behavior to student achievement has made enormous strides. What was once a very limited collection of scattered results that did not hang together to form easily interpretable patterns has become an increasingly integrated knowledge base that includes a sizeable collection of replicated correlational findings, many of which have been validated experimentally. The highlights of these findings are reviewed below. They are subdivided into quantitative findings that identify general classroom characteristics associated with high levels of student achievement gain and qualitative findings that suggest particular managerial and instructional behaviors involved in bringing about these achievement gains.

### Quantitative Findings

The most basic and consistently replicated findings link students' achievement gains to their opportunity to learn the material, and in particular to the degree to which their teachers carry the content to them personally through active instruction and direct supervision of their learning efforts.

Opportunity to learn/content covered. Amount learned is related to opportunity to learn, whether measured in terms of curriculum pages covered (Good, Grouws, & Beckerman, 1978; Borg, 1979) or percentage of test items that were taught through lecture or recitation activities in class (Arehart, 1979; Cooley & Leinhardt, 1980; Dunkin & Doenau, 1980; Nuthall & Church, 1973; Smith, 1979). In short, more content coverage means greater opportunity to learn (assuming that the time devoted to the topic and the quality of the instruction are sufficient to insure that the students will master the content if they put forth reasonable effort). Opportunity to learn is bounded by the length of the school day and the school year, which determine the total amount of time available for instruction. However, available time is only indirectly related to content coverage and ultimately to student achievement; how the available time is used determines student opportunity to learn more directly (Karweit, 1985; Levin, 1984). In particular, the four variables discussed below determine student opportunity to learn in typical classrooms.

Role definition/expectations/time allocation. Achievement is maximized when teachers emphasize academic instruction as a major part of their role, expect their students to master the curriculum, and allocate most of the available time to curriculum related activities (Brophy & Evertson, 1976; Fisher et al., 1980; Stallings, 1975). Such teachers are seen as businesslike and task-oriented, and they allocate most of their available classroom time to activities with academic objectives rather than to activities with other types of objectives (personal adjustment, group dynamics) or to activities with no clear objective at all ("free time," student choice of games or pastimes). These teachers assume personal responsibility for seeing that their students master the curriculum. If the students don't learn something the first time they reteach them in a more thorough or different way, and if the assigned curriculum materials or evaluation devices do not seem to be appropriate for the students, they obtain or develop better ones.

Classroom management/student engaged time. Not all time allocated to academic activities is actually spent engaged in those activities. Student engagement rates depend on the teacher's ability to organize and manage the classroom as an efficient learning environment where academic activities run smoothly, transitions are brief and orderly, and little time is spent getting organized or dealing with inattention or resistance. High task engagement rates attained through such successful classroom management methods are among the most frequent and powerful correlates of student achievement (Brophy & Evertson, 1976; Coker, Medley, & Soar, 1980; Fisher et al., 1980; Good & Grouws, 1977; Soar & Soar, 1979; Stallings, 1975; Stallings, Cory, Fairweather, & Needels, 1977, 1978).

A great deal has been learned in the last 15 years about effective classroom management as defined in the previous paragraph. Pioneering work by Kounin (1970) followed up later by Brophy and Evertson (1976), Good and Grouws (1977), and especially Evertson, Emmer, and their colleagues (Emmer, Evertson, & Anderson, 1980; Evertson & Emmer, 1982; Evertson, Emmer, Sanford, & Clements, 1983) has shown that effective classroom managers succeed not so much because they know how to respond to problems of inattention and disruption when these occur, but because they are adept at preventing the occurrence of such problems in the first place. This work has led to the recognition that classroom management is best construed not as a process of compelling conformity from students who know what to do but refuse to do it, but instead as a process of being clear and consistent in teaching students desired classroom rules and procedures. Furthermore, this work has shown that good classroom management (in the sense of control over student behavior) and good instruction in the formal curriculum are intimately linked and mutually supportive. Teachers must not merely obtain but <u>maintain</u> student engagement in academic activities, and this means that the activities themselves must be appropriate for the students and that the teachers must be effective in implementing them.

Effective classroom managers are clear about their expectations. At the beginning of the year, they take time to instruct their students and provide any necessary practice in following classroom rules and procedures, and they follow up by reminding the students of these rules and procedures when they are supposed to be carried out and by intervening to provide corrective feedback or apply announced consequences if necessary. In general, their classrooms reveal: (1) good preparation of the physical environment and installation of routines and procedures concerning physical movement in the classroom, distribution of supplies, transitions between activities, and other housekeeping and "daily routine" matters; (2) continuous monitoring of events occurring at all points in the room (even when actively instructing a group or working with individuals); (3) smoothness and continued momentum in lesson pacing (accomplished partly through good preparation for instruction and partly through responding to inattention and potential disruption by using subtle intervention techniques that allow accomplishment of management goals without disrupting the flow of lessons); (4) variety and appropriate level of challenge in assignments; (5) clear accountability procedures and consistent follow-up concerning working on and completing assignments; and (6) clarity about when and how students can get help when they need it and about what options are available to them when they finish assigned work. For reviews of this research, see Brophy (1983) and Doyle (1986), and for suggestions about practical application, see Good and Brophy (1984).

Consistent success/academic learning time. To learn efficiently, students must be engaged in activities that are appropriate in difficulty level and otherwise suited to their current achievement levels and needs. It is important not only to maximize content coverage by pacing students briskly through the curriculum, but also to see that they make continuous progress all along the way, moving through small steps with high or at least moderate rates of success and minimal confusion or frustration (Brophy & Evertson, 1976; Fisher et al., 1980). In practice, this means that the students would be able to answer most (perhaps three-fourths) of the teacher's questions during group lessons in which the teacher is available to provide guidance and immediate corrective feedback, and would be able to sustain even higher (90-100 percent) success rates when they must work independently for extended periods without teacher supervision. More will be said about these high success rates in subsequent sections of the paper. For now, however, it should be noted that the high success rates described here are construed to result from effort and thought, not mere "automatic" application of already overlearned algorithms. Thus, high rates of success do not necessarily imply success that is obtained quickly or easily.

To point up the importance of high rates of success, the authors of Phase III-B of the Beginning Teacher Evaluation Study (Fisher et al., 1980) coined the term academic learning time (ALT), which they defined as the time that students spend engaged in academic tasks that they can perform with high rates of success. ALT consistently showed significant positive correlations with achievement in their study, although achievement was associated with moderate rather than high rates of success under some circumstances.

Active teaching. Students achieve more in classes where they spend most of their time being taught or supervised by their teachers rather than working on their own or not working at all (Arehart, 1979; Brophy & Evertson, 1976; Good & Grouws, 1977; Stallings, 1975; Stallings et al., 1977, 1978). Active teaching connotes frequent lessons (whole class or small group, depending on grade level and subject matter) in which the teacher presents information and develops concepts through lecture and demonstration, elaborates this information in the feedback given following responses to recitation or discussion questions, prepares the students for follow-up assignments by giving instructions and going through practice examples, monitors progress on assignments after releasing the students to work independently, and follows up with appropriate feedback and reteaching when necessary. The teacher carries the content to the students personally rather than depending on curriculum materials alone to do so, but conveys information mostly in brief presentations followed by recitation or application opportunities. There is a great deal of teacher talk, but most

of it is academic rather than procedural or managerial, and much of it involves asking questions and giving feedback rather than extended lecturing.

Comments on quantitative findings. The school effects findings reviewed in the previous section and the quantitative teacher effects findings reviewed in the present section complement each other in demonstrating that achievement gain is associated with a complex of factors including placing high priority on achievement gain as a goal and adopting congruent definitions of the teacher's role, adopting high but realistic expectations about the students' ability to master the curriculum and the teacher's ability to teach it to them, and allocating most available time to academic activities so as to maximize content coverage and student opportunity to learn. By implication, these findings identify two types of teachers who will be relatively unsuccessful in eliciting achievement gain from their students: teachers who are burned out or who for whatever reason are not committed to any clear-cut educational goals (who devote a great deal of classroom time to busywork or noneducational pastimes), and teachers who place a high priority on affective or social outcomes but a low priority on achievement outcomes (so that less of the available time is spent instructing students in the formal curriculum). Some of the latter teachers may be effective in realizing the goals they choose to emphasize, although the little research that is available on teachers with contrasting goal priorities (Prawat, 1985) suggests that teachers who emphasize affective and social outcomes in addition to achievement outcomes tend to get better results than teachers who emphasize affective and social outcomes instead of achievement outcomes.

The findings concerning classroom management effectiveness and student engaged time identify a third class of teachers who will be relatively unsuccessful in eliciting student achievement gains: Teachers who may be committed to achievement outcomes but unable to attain them for lack of classroom management skills. Such teachers would benefit from research-based classroom management retraining programs, which have proven effective in assisting teachers to increase student engagement rates and ultimately student achievement levels (Evertson, 1985).

The findings on active instruction identify a fourth class of teachers likely to be relatively unsuccessful in eliciting student achievement gains: Teachers who rely on individualized learning modules and other materials-based approaches to individualized instruction to carry the content to the students rather than doing so themselves through active whole-class or small-group instruction. Materials-based approaches have worked under some circumstances, but they typically do not work well in ordinary classrooms where one teacher must work with 20

to 40 students. The problem is not with the abstract principle of individualized instruction that calls for beginning where students are and moving them along at their own pace. Instead, the problem is that in practice, individualized instruction in the typical classroom shifts a great deal of responsibility for planning and managing learning from the teacher to the students themselves and shifts responsibility for carrying the content to the students from the teacher to the materials. This is workable and may even have certain advantages when the teacher is continually available to provide close supervision and immediate help when needed, but it does not work well when students must work on their own for extended periods of time, trying to learn through interacting with the curriculum materials without much guidance or help from the teacher. This method of learning demands a combination of functional literacy, direction following skills, independent learning skills and habits, and sustained concentration and motivation that is almost nonexistent in the primary grades and likely to be seen in only a minority of students in the intermediate and secondary grades. These findings imply that "teacher proof curricula" and related approaches that attempt to carry the content to students through curriculum materials (or computer programs, for that matter) not only have not worked but cannot work under the constraints imposed by the typical classroom. Unless they are prepared to change the basic nature of schooling, would-be school innovators will need to work <u>through</u>, not around, teachers.

The individualized learning package approach can be used effectively, however, in special classrooms with small student-teacher ratios. Crawford (1983) studied instruction in special compensatory education classes for Title I students. These classes were small (5 to 10 students), intended to remediate weaknesses in basic reading and mathematics skills, and taught by specially trained teachers assisted by paraprofessional aides. Most of the process-outcome correlations obtained in this study replicated findings from regular classrooms, but there were two interesting exceptions: Instead of the usual negative relationships, positive relationships with achievement were observed for teacher time spent in one-to-one individualized instruction and for student time spent working on relatively challenging rather than relatively easy assignments. These findings indicate that in special classes with small student-teacher ratios, teachers can move the students through curricula at a faster pace, can provide more tutorial and individualized instruction, and can assign more difficult work because they are able to continually monitor everyone's progress and provide immediate help when needed.

The research reviewed so far underscores the role of active instruction from the teacher in producing student achievement gain. Such instruction can be provided in tutorial

form in special classes with small student-teacher ratios, and it can be provided to small groups in classrooms where the teacher has developed appropriate assignments and installed effective seatwork management procedures so that students are engaged in worthwhile academic activities in between their small-group lessons from the teacher. The individualized approach is not feasible in the typical classroom, however, and even the small-group approach is likely to strike most teachers as more trouble than it is worth unless they have an aide available to supervise seatwork while they teach small-group lessons (or unless they believe that the class is so heterogeneous that they are forced to provide differentiated instruction to small homogeneous groups). Consequently, most teachers will opt for the traditional whole-class instruction/recitation/seatwork method as their primary approach to instruction. Process-outcome research on teaching has identified certain qualitative elements of this approach that are associated with student achievement gain.

Qualitative findings

The qualitative findings concern teachers' management of lessons when instructing the whole class or a subgroup of students and their management of work on assignments during seatwork times. The findings concerning management of lessons can be subdivided according to the three major instructional tasks involved in typical classroom lessons: giving information (structuring), asking questions (soliciting), and providing feedback (reacting).

Giving information (structuring)

There is now a good deal of both correlational and experimental data on presentation of information to students. These data hang together well to form a consistent pattern and provide strong support for the ideas of Ausubel, Bruner, and other "cognitive structuralists" who stress the importance of structuring the content so that students can learn it as an organized body of knowledge rather than trying to memorize what they can of what seems to be a random list of isolated facts. Research on oral presentations in classrooms has yielded stronger and more consistent relationships with student achievement than earlier research involving presentation of written text to college students.

Structuring. Achievement is maximized when teachers not only actively present material to their students but structure it by: beginning with overviews, advance organizers, or review of objectives; outlining the content and signaling transitions between lesson parts; calling attention to main ideas; summarizing subparts of the lesson as it proceeds; and reviewing main ideas at the end (Alexander, Frankiewicz, & Williams,

1979; Armento, 1977; Dunkin, 1978; Fortune, 1967; Schuck, 1981, 1985; Wright & Nuthall, 1970). Apparently, organizing concepts and analogies help students link new content to already familiar ideas, overviews and outlines help them to develop learning sets to use in assimilating the content as it unfolds, rule-example-rule patterns and internal summaries tie specific information items to integrative concepts, and summary reviews integrate and reinforce the learning of major points. Together, these structuring elements not only facilitate memory for the information but allow for its retention as an integrated whole with recognition of the relationships between parts.

Redundancy/sequencing. Achievement is higher when the content is sequenced in a logical way and presented with sufficient redundancy to make it easy for students to follow the presentation and see the linkages from one sentence to the next as it unfolds (Armento, 1977; Nuthall & Church, 1973; Smith, 1985; Smith & Sanders, 1981).

Clarity. Students achieve more when their teachers make clear presentations marked by continuity and precision of language rather than interruptions due to false starts or meandering into side issues, hemming and hawing, or vague terminology. Most of the presently available information is on factors that detract from clarity (see reviews by Rosenshine, 1968 and by Smith & Land, 1981), although recent work has begun to develop methods of conceptualizing and measuring positive aspects of clarity such as sufficiency of definitions, accuracy of examples, and explicitness of explanations (Book & McCaleb, 1984; Hines, Cruickshank, & Kennedy, 1985; McCaleb & White, 1980). In general, clarity of presentation is one of the more consistent correlates of achievement, especially in situations involving learning of new or difficult material.

Enthusiasm. Teacher enthusiasm when presenting material relates more centrally to student attitudes than to achievement, but when it does correlate significantly with achievement gain it tends to correlate positively (Armento, 1977; Bettencourt, Gillett, Gall, & Hull, 1983; Hughes, 1973).

Questioning the students (soliciting)

The findings reviewed in this section concern the teacher's management of public response opportunities that occur during recitations and discussions.

Difficulty level of questions. Studies of the difficulty level of questions (the likelihood that a question will be answered correctly by the first respondent) have produced mixed results. It seems clear that most (perhaps 75 percent) of teachers' questions should elicit correct answers, and that

most of the rest should elicit overt, substantive responses (incorrect or incomplete answers) rather than failures to respond at all (Anderson, Evertson, & Brophy, 1979; Brophy & Evertson, 1976; Wright & Nuthall, 1970). Even these guidelines are of limited usefulness, however, because they are generalized across instructional contexts, and optimal question difficulty probably varies with context. For example, basic skills instruction requires a great deal of drill and practice, which means frequent, fast-paced drill/review lessons during which most questions should be answered rapidly and correctly. However, when teaching complex cognitive content, or when trying to stimulate their students to generalize from, evaluate, or apply what they are learning, teachers will need to raise questions that few students can answer correctly (as well as questions that have no single correct answer at all). Similarly, relatively frequent errors may be expected early in the unit when new learning is occurring, but few errors should occur later in the unit when mastery levels are supposed to have been achieved.

The quality of errors should also be taken into account. Some errors occur because students have the right general idea but make a minor miscalculation, or because they use sound logic but base it on assumptions that are plausible but happen to be faulty. Such "high quality" errors are understandable and may even provide helpful guidance to the teacher. However, errors that suggest inattention, hopeless confusion, or alienation from the material are undesirable.

Cognitive level of questions. Data on the cognitive level of questions (as distinct from their difficulty level) have also produced mixed results, so that reviewers (Redfield & Rouseau, 1981; Winne, 1979) have drawn conflicting conclusions. It is clear that the data refute the simplistic (but frequently assumed) notion that higher-level (application, analysis, synthesis, evaluation) questions are categorically better than lower-level (knowledge, comprehension) questions. Several studies indicate that lower-level questions facilitate learning, even learning of higher-level objectives (see Brophy & Good, 1986, for a review). Furthermore, even when the frequency of higher-level questions correlates positively with achievement, the absolute numbers on which these correlations are based typically show that only about 25 percent of the questions asked were classified as higher-level. Thus, even in situations (involving teaching to higher-level objectives) that call for teachers to ask "more" or "frequent" higher-level questions, we should not expect that all or even a majority of their questions will be higher-level questions. Lower-level questions are valuable too, both in their own right and as ways to set the stage for or to follow up on higher-level questions.

Post-question wait-time. Studies of secondary level science instruction have shown higher achievement when teachers pause for 3 to 5 seconds (rather than for one second or less) after asking a question, in order to give the students time to process the question and formulate an answer before calling on one of them to respond (Tobin, 1980; Tobin & Capie, 1982). Research in other contexts also generally supports the value of longer wait-times, although more clearly for the upper grades than for the lower grades (Tobin, 1983). It appears that the length of pause following a question should vary directly with the difficulty level and especially the complexity or cognitive level of the question. A question calling for application of abstract principles should require a longer pause than a factual question.

Selection of respondents. Findings on selection of respondents to questions tend to vary with context. In the early grades, and especially in small-group lessons, it is important for each student to respond overtly and frequently to teacher questions. In small-group reading lessons, this can be accomplished by allowing each student to take a turn in order, training the students not to call out answers or words, and calling on nonvolunteers as well as volunteers (Anderson, Evertson, & Brophy, 1979). Here, it is important to prevent assertive students from coopting other students' response opportunities, and to insure that reticent students participate regularly even though they may seldom volunteer.

However, in whole-class settings and increasingly with grade level, it becomes less feasible to have all students participate overtly, let alone to insure that all participate roughly equally. Fortunately, frequency of overt participation in lessons does not appear to correlate with achievement in the upper grades (Hughes, 1973). In the upper grades, maintaining continuity and keeping the lesson moving along at a brisk pace seems to be more important than insuring the overt participation of each individual student. This is partly because the switch from emphasis on basic skills in the early grades to emphasis on conceptual knowledge in the later grades reduces students' needs for overt practice, and partly because older students have more highly developed skills for learning through watching and listening than younger students do.

Frequency of academic questions. The sheer frequency of academic questions asked by teachers typically correlates with student achievement gain. Presumably this is because recitation is of value in its own right (Gall et al., 1978) and because teachers who who conduct recitation lessons more often tend to do more active teaching generally.

Reacting to student responses

Findings on teacher reactions to student responses are weaker, less consistently replicated, and less supported by experimental data than the findings reviewed above, except for the basic finding that feedback reactions are important (teachers who provide regular and extensive feedback elicit higher achievement gain than teachers who typically give minimal feedback or frequently fail to give any feedback at all).

Reactions to correct responses. It appears to be important that correct responses be acknowledged as correct (because even if the respondent knows that the answer is correct, some of the onlookers may not). However, it does not appear important (to achievement gain, at least) that such positive feedback go beyond mere affirmation of the correctness of the response to the point of praising the student (delivering social reward, rather than mere affirmation). The frequency of teacher praise of correct responses usually correlates positively with achievement, but these correlations are usually quite low and sometimes are negative (Brophy & Evertson, 1976; Stallings, 1975).

Perhaps this should not be surprising, because public praise of students who supply correct answers is often intrusive and distracting, and it may embarrass the recipient, especially if the accomplishment was not especially praiseworthy in the first place. In any case, teachers who maximize achievement gains are sparing rather than effusive in praising correct answers. Review of the literature on teacher praise (Brophy, 1981) suggests that it is more likely to be effective when it is specific rather than global, when it is used with dependent or anxious students rather than assertive or confident students, when it is delivered privately rather than publicly, and when it is delivered in ways that focus attention on the content or accomplishment rather than on the teacher or the recipient of the praise.

Correlations of praise rates with achievement gain are especially likely to be positive (although still weak) in studies of schools serving students from low socioeconomic status families or teachers instructing low-achieving students. Therefore, teachers supplying compensatory education to Chapter 1 students probably should praise these students more often than other teachers praise their students (perhaps 10 to 20 percent of their students' correct answers might be praised). Beyond some optimal level, however, public praise of correct answers to teachers' questions becomes intrusive and counterproductive. Furthermore, it appears to be more important that teachers create a supportive learning environment and be patient and encouraging throughout their interactions with

their students than that they praise a high percentage of the correct answers that these students supply during classroom recitations.

Reactions to incorrect responses. In responding to students' incomplete or incorrect answers, it appears that teachers should typically acknowledge whatever part may be correct and then, if there are good prospects for success, should try to elicit an improved response. Several studies have suggested that teachers who elicit strong achievement gains are relatively more likely to sustain interaction with the original respondent by repeating or simplifying the question or by giving clues than to terminate the interaction by giving the answer or calling on another student to supply it (Anderson, Evertson, & Brophy, 1979; Clark et al., 1979; Crawford, 1983). Whether or not the teacher should seek to elicit an improved response will depend on several situational factors. Doing so takes time and slows lesson pacing, for example, so that it is not advisable when time is running out or when the loss of lesson momentum might lead to significant inattention or disruption problems. Also, certain students are prone to become extremely anxious or embarrassed when "put on the spot" in this way, so it is sometimes better to terminate interactions with them rather than continue to question them. Finally, although certain questions (especially complex, higher-level questions) lend themselves well to simplification through rephrasing or division into smaller parts, other questions (especially those calling for knowledge of specific facts) do not, so that continued attempts to elicit improved responses to the latter questions may amount to "pointless pumping" of the student (Brophy & Evertson, 1976; Good, Ebmeier, & Beckerman, 1978).

Reacting to failure to respond. Seeking to elicit an improved response is especially important when students make no response at all to the original question (as opposed to responding overtly but incorrectly). Teachers who allow such failures to respond elicit less achievement from their students than teachers who train their students to respond overtly to questions, even if only to say "I don't know" (Brophy & Evertson, 1976; Evertson, Anderson, Anderson, & Brophy, 1980; Wright & Nuthall, 1970).

Reacting to student questions and comments. Teachers who elicit higher achievement gains tend to discourage irrelevant student questions and comments, but to respond positively to relevant questions and comments by answering them, redirecting them to the class, or incorporating them into the flow of the lesson (Evertson et al., 1980; Flanders, 1970). Such use of student ideas appears to become more important with each succeeding grade level, as students become both more able to

contribute useful ideas and more sensitive to whether teachers treat their ideas with interest and respect.

Managing assignments

Although independent seatwork is probably overused and is not a substitute for active instruction by the teacher or for drill/recitation/discussion opportunities, seatwork (and homework) assignments provide needed practice and application opportunities. Ideally, such assignments will be varied and interesting enough to motivate student engagement, new or challenging enough to constitute meaningful learning experiences rather than pointless busywork, and yet easy enough to allow students to attain high levels of success if they put forth reasonable effort (Brophy & Evertson, 1976; Fisher et al., 1980; Kounin, 1970). Success rates will have to be very high (near 100 percent) for assignments on which students are expected to work on their own. Lower (although still generally high) success rates can be tolerated when students who need help can get it quickly. Once again, it should be noted that these success rates are assumed to result from sustained student effort and thought, not mere automatic application of familiar algorithms.

It should also be noted that student success rates are determined not only by the difficulty level of the work itself but by the degree of thoroughness with which the teacher prepares the students for the assignment before releasing them to work on it independently. Teachers who elicit higher achievement gains from their students tend to explain assignments thoroughly and go over several practice examples before releasing the students to work independently, and to circulate in order to monitor performance and be available to provide immediate help to those who need it during seatwork times.

Such teachers also install effective seatwork management systems. Their students know what work they are accountable for, how to get help when they need it, and what to do when they finish. Performance is monitored for completion and accuracy, and the students receive timely and specific feedback. Poor performance produces not only feedback but reteaching, and follow-up assignments designed to insure that the material is mastered.

Good seatwork management is especially important when teachers are instructing small groups and thus do not wish to be interrupted by students working on seatwork assignments. Anderson, Brubaker, Alleman-Brooks, and Duffy (1985) suggest that after making seatwork assignments, teachers should spend several minutes circulating among students to make sure that all of them get started successfully before beginning small-group instruction. Similarly, they should take a few

minutes during the transition between groups to circulate and assess progress. If a common source of confusion is detectable, the teachers may wish to provide a mini-explanation to the class as a whole at such times; otherwise they would just monitor and provide feedback to individuals. During small-group instruction times, teachers can eliminate the need for students working on assignments to wait for long periods of time when they become confused by appointing certain students to act as resource persons and helpers, establishing a buddy system or other approaches to cooperative learning, or training students to come up to the teacher for help during small- group instruction but wait quietly until recognized.

Considering their importance and the time spent working on them, remarkably little research is available on the nature and management of assignments. Osborn (1984) has found that assignments are frequently either too easy or too difficult for most of the students, poorly coordinated with what is being taught during group lessons at the time, or designed in such a way as to be more likely to confuse or mislead than to teach the target concepts. She presents guidelines for judging seatwork and homework assignments that are very basic but worthy of attention because they appear to be violated so frequently (Examples: Assignments should provide practice or application opportunities related to the important objectives being taught in the unit; extra tasks should be available for students who need extra practice; tasks should contain enough content to insure that students learn the material rather than merely get exposed to it; brief explanations of purpose should be included; and response modes should feature actual reading and writing rather than circling, underlining, drawing arrows, etc.).

Teachers presumably could make up for many of these deficiencies by providing clear explanations, but the work of L. Anderson et al. (1985) suggests that they typically do not do so. These investigators showed that students often did not understand the purpose of seatwork assignments and tended to think about the assignments primarily in terms of finishing them rather than in terms of learning what they were supposed to be learning. Presumably this was because, when presenting the assignments in the first place, the teachers tended to concentrate on what to do and how to do it but seldom included statements about the objectives of the assignments or explicit explanations of the cognitive strategies to be used in responding to them. Even when circulating among the students to monitor progress, the teachers tended to concentrate on keeping the students busy and urging them to finish the work rather than to attend to the quality of their answers or to question them about their answers in order to determine whether they understood what they were doing and were acquiring the intended concepts and skills.

In general, much more information is needed about what kinds of classroom tasks and assignments are appropriate for accomplishing particular objectives with particular students. Somewhat more information is available on managing assignments than is available on the nature of the assignments themselves, but additional information is needed here, too (especially regarding methods of checking work, providing feedback, and arranging for any needed remedial instruction or practice while continuing to manage the classroom as a whole and to move forward through the curriculum).

Homework. Most studies on the topic suggest that homework provides a useful supplement to classroom instruction and increases student achievement (Good & Grouws, 1979; Keith, 1982; Rickards, 1982; Strother, 1984; Walberg, Paschal, & Weinstein, 1985). Beneficial results are especially likely if the homework is not merely assigned but is checked and produces feedback from the teacher. Very little information is available about how much or what kind of homework to assign. It seems likely that everything said above about seatwork would apply to homework, and in addition, that it would be especially important to make sure that the students understood and could handle homework assignments on their own, because the teacher would not be available to provide assistance.

The studies that support the value of homework typically involve relatively modest homework assignments (10 or 15 minutes per night rather than an hour or more). It seems intuitively obvious that the length and difficulty levels of homework assignments should be correlated with the ages and ability levels of the students, and that for a particular class of students there should be an optimal amount of homework that would produce better results than other amounts that would be either too much or too little. This is speculation, however; information is badly needed on how much and what kind of homework to assign to different types of students.

Cooperative learning methods. Cooperative learning methods provide an alternative to traditional independent seatwork as a method for managing students' work on assignments. Although sometimes discussed as if they were wholesale replacements for the traditional whole-class instruction/recitation/seatwork approach, most cooperative learning methods are actually a variation of this approach in which whole-class instruction and recitation take place as usual but some or all of the work on assignments is done by small groups of students working cooperatively rather than by individuals working alone. Cooperative learning methods are worthy of consideration because, unlike most other proposed innovations to traditional schooling methods, they are relatively cheap and easy to implement by individual teachers and testaments to their effectiveness are backed by a great deal of credible classroom

research. The methods have been used with positive results on affective outcomes and neutral to positive results on achievement outcomes, mostly in grades 4 through 9 (see Slavin, 1983, for a comprehensive review).

The best known cooperative learning programs can be divided into two types, one that is more purely cooperative and another that combines cooperation within groups with competition between groups. The more purely cooperative methods include Jigsaw (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), Group Investigation (Sharan et al., 1984), and the various methods developed by David and Roger Johnson (Johnson, Johnson, Holubec, & Roy, 1984). These methods have been used primarily in social studies and in connection with assignments that call for work on higher-level cognitive objectives. In these methods, students work in four- or five-member groups to discuss or debate issues or to develop a group project such as a biography of a famous person, a research report, or a display or presentation to be made to the rest of the class. To make sure that everyone participates actively, each individual student is given certain unique information that the group will have to take into account in developing its final product, or else the task is divided into differentiated subtasks that allow each individual to contribute in an active and unique way. In general, these cooperative learning methods work best when tasks are structured to create: (1) positive interdependence (group members recognize that they are interdependent on one another for achieving a successful outcome); (2) face-to-face interaction among the members; (3) individual accountability for mastering assigned material (it is not possible for the brighter or more assertive students to ignore other group members or cover for them if they fail to do what they are supposed to do); and (4) training of students in appropriate small-group interaction and cooperation skills (Johnson et al., 1984).

The Student Team Learning methods developed by Slavin (1983) and his colleagues involve dividing the class into four- or five-member teams. Members of the same team cooperate to help one another master material and prepare for competition against other teams. Members earn points for their teams according to their degree of success in answering questions on the content, with winning teams as well as outstanding individual performances receiving prizes or recognition for their success. Student Team Learning methods include Teams-Games-Tournament (TGT), Jigsaw II, Student Teams-Achievement Divisions (STAD), and Team-Assisted Individualization (TAI). Student Team Learning methods do not involve creation of a single group product like the more purely cooperative learning methods do. Instead, each individual student works on the same set of assignments or an individualized set of assignments and prepares for testing on the content he or she has been learn-

ing. However, the team competition and group reward system motivates team members to help one another by discussing the work, providing tutoring and encouragement, administering quizzes or drill exercises, and checking answers. Student team learning methods have been used mostly with assignments involving practice of basic skills, especially mathematics assignments.

Cooperative learning methods appear to be at least comparable to traditional independent seatwork methods in fostering student achievement gain. Student Team Learning methods, in fact, typically produce higher achievement than traditional independent seatwork methods, at least on mathematics computation tests (there usually is no significant difference on mathematics concepts tests). Furthermore, all of the cooperative learning methods foster progress toward affective and social outcomes. Because they bring heterogeneous groups of students together under cooperative learning conditions, these methods tend to lead to better attitudes and more cooperative interpersonal contacts between students who differ in achievement level, sex, race, ethnicity, and handicapping condition, so they are especially useful in schools where desegregation or mainstreaming issues are of particular concern.

Certain limitations on cooperative learning methods should be noted. First, these methods have been used most frequently in mathematics, social studies, and language arts classes in grades 4 through 9. They may be less relevant or more difficult to implement for teachers working with primary grade students or upper secondary grade students, or for any teachers instructing students in reading, writing, laboratory science, or foreign languages. Also, these methods require transfer of initiative and responsibility for managing work on assignments from the teacher to the students themselves, and this may create problems for teachers with marginal classroom management skills or for any teachers working in classrooms composed of homogeneously grouped low achievers (Slavin, 1983). In classes where all of the students are low achievers and many are frustrated or alienated learners, the students may not be able to profit as much from cooperative small-group activities or may need much more extensive training in how to stay on task and work cooperatively during these activities than students in other types of classrooms would need.

## Interactions with Context and Learner Characteristics

Even the most widely replicated process-outcome relationships usually must be qualified by references to the context of instruction. Interactions with context typically involve

relatively minor elaborations of main effects, although occasionally interactions are more powerful than main effects (Brophy & Evertson, 1976; Solomon & Kendall, 1979). Certain interaction effects appear repeatedly and constitute well established findings. Many of these involve grade level differences, subject matter differences, or differences associated with student socioeconomic status/ability/affect.

Grade Level

In the early grades, classroom management involves a great deal of instruction in desired routines and procedures. Less of this instruction is necessary in later grades, but there it becomes especially important to be clear about expectations and to follow up on accountability demands, especially those concerned with completing and turning in work on time. Lessons in the early grades involve basic skills instruction, often conducted in small groups and under conditions in which it is important that each student participate overtly and often. In later grades, lessons typically are with the whole class and involve applications of basic skills or consideration of more abstract content. Here, overt participation is less important than factors such as the degree to which the teacher structures the content, is clear and well organized in making statements and asking questions, and projects enthusiasm. Finally, the praise and symbolic rewards that are common in the early grades give way to the more impersonal and academically centered instruction common in the later grades, although it is important for teachers in the later grades to treat students' contributions with interest and respect.

These grade-level differences in the nature of teaching and learning in different classrooms must be taken into account in considering the potential implications of process-outcome research for classroom instruction. So must related considerations such as the particular objectives of an activity and its place within the larger unit of instruction. For example, information about structuring and sequencing the content is of most relevance to situations in which the teacher is presenting new content to the students (especially abstract or otherwise complex content), but it is less relevant to brief demonstrations of specific skills and not relevant at all to activities that do not involve presentation of content. Similarly, information about the values of wait-time following questions and about simplifying questions in an attempt to elicit improved responses is most relevant to discussions involving higher-level questions, less relevant to recitations involving lower-level questions, and not relevant at all to activities that do not involve asking the students questions. These considerations should be intuitively obvious to anyone, yet it is not hard to find teacher educators or program developers who suggest that a single lesson format is appropriate for all

academic activities or local administrators or state officials attempting to use a single classroom observation instrument for assessing instruction at every grade level or in every kind of academic activity. Although such individuals sometimes cite selected process-outcome research in attempting to justify their actions, in fact, process-outcome research considered as an integrated body of information provides no support for such actions (see Brophy, in press and Brophy & Good, 1986 for more on these issues).

Subject Matter

In addition to the relatively general principles reviewed here, process-outcome research has suggested principles for teaching particular subject matter at particular grade levels. For example, Anderson, Evertson, and Brophy (1979, 1982) developed, tested, and revised a set of principles for organizing and instructing small groups of students in the primary grades, particularly reading groups. One principle that emerged from correlational work and was confirmed in a field experiment was that better achievement results were obtained when teachers proceeded in order around the group when allocating reading turns or asking questions (rather than skipping around randomly, as is recommended more typically). These authors speculated that the "ordered turns" method produced better results because: (1) it insures roughly equal participation by all group members (earlier research relating to teacher expectation effects had shown that teachers who think they are questioning students randomly and roughly equally tend to give more response opportunities to brighter and more assertive students); (2) it provides structure and predictability to small-group reading lessons that may be helpful to anxious or confused students; and (3) it minimizes handwaving and other vigorous attempts by the more assertive and extroverted students to get the teacher to call on them, thus increasing the degree to which all of the students attend to the content being taught rather than to issues of who gets to be called on by the teacher. For these reasons, the authors recommend the ordered turns method for small-group instruction in beginning reading, but they caution that the method would be overly constricting and otherwise unfeasible for use in whole-class settings and that many of its advantages would be negated even in small-group settings in higher grade levels where students are sophisticated enough to anticipate what they will be asked to do and concentrate on practicing that rather than paying attention to what goes on in the meantime (Kounin, 1970, noted the latter as a frequent problem and recommended that teachers deliberately be unpredictable in allocating response opportunities so as to hold students accountable for paying attention continuously).

Good and Grouws (1979) developed guidelines for fourth-grade whole-class mathematics instruction that called for beginning with eight minutes of review (going over the previous day's homework assignment and asking several mental computation exercises), then devoting about 20 minutes to development of concepts (review prerequisites, explain and demonstrate new concepts or skills, assess student comprehension through questioning and controlled practice, repeat and elaborate as necessary), then devoting about 15 minutes to supervised seatwork, and then finishing by assigning about 15 minutes of homework. These guidelines can be expected to apply to whole-class instruction in fourth-grade mathematics (for which they were developed in the first place), but they might well have to be adjusted for whole-class instruction in mathematics at other grade levels, and they simply do not apply (except perhaps accidentally) to instruction in other subject matter or to mathematics instruction in classrooms that use small-group or individualized rather than whole-class instructional methods.

These examples are given both to underscore the need for taking into account grade level, subject matter, and the nature and objectives of the activity in attempting to draw inferences about appropriate instruction from process-outcome research and to alert readers to the fact that a great deal of research on instruction in particular grade levels and subject matter areas exists in addition to the relatively generalizable studies reviewed here. For examples, see the Handbook of Reading Research (Pearson, Barr, Kamil, & Mosenthal, (1984) and the chapters dealing with particular subject matter areas in the Handbook of Research on Teaching (Wittrock, 1986). It seems likely that most of what is going to be discovered about relatively generalizable process-outcome relationships has already been discovered, and that the most important new contributions to the process-outcome literature in the future will come from studies of instruction in particular subject matter at particular grade levels that feature focused attention on the nature of the content or skills to be taught and on related subject matter-specific pedagogy.

Student Socioeconomic Status/Ability/Affect

Student socioeconomic status is taken here as a "proxy" for a complex of correlated cognitive and affective differences between subgroups of students. The cognitive differences involve IQ, ability, or achievement levels. Interactions between process-outcome findings and student socioeconomic status or achievement level indicate that low socioeconomic status or low-achieving students need more control and structuring from their teachers: more active instruction and feedback, more redundancy, and smaller steps with higher success rates. This will mean more review, drill, and prac-

tice, and thus more lower-level questions. Across the school year, it will mean exposure to less material, but with emphasis on mastery of the material that is taught and on moving the students through the curriculum as briskly as they are able to progress. To the extent that these students do progress and become more like high socioeconomic status or high-achieving students, they will then need relatively less structuring and more challenge.

Affective correlates of socioeconomic status include the degree to which students feel secure and confident vs. anxious or alienated in the classroom. High socioeconomic status students are likely to be confident, eager to participate, and responsive to challenge. They typically want respect and require feedback, but do not require a great deal of encouragement or praise. They tend to thrive in an atmosphere that is academically stimulating and somewhat demanding. In contrast, low socioeconomic status students are more likely to require warmth and support in addition to good instruction from their teachers, and to need more encouragement for their efforts and more praise for their successes. It appears to be especially important to teach them to respond overtly rather than to remain passive when asked a question, and to be accepting of their relevant call-outs and other academic initiations when they do occur. This combination of demandingness and supportiveness is part of what is involved in adopting positive but realistic expectations and a teacher role definition that includes assuming responsibility for making sure that the students learn (as described earlier in this paper).

Neither race nor ethnicity have been investigated systematically in process-outcome research, so that nothing is known about their influences on relationships between teacher behavior and student achievement. Other than indirect relationships mediated through socioeconomic status, however, the probability of discovering process-outcome patterns unique to particular racial or ethnic groups is very low. As noted, process-outcome research yields more powerful main effects than interactions, and the interactions that do appear tend to be ordinal rather than disordinal.

## Research in Special Educational Settings

Most research on compensatory education in resource rooms or other special educational settings is relatively uninformative because it does not include extensive classroom observation. However, a few such studies have been reported, so they are given special mention here.

The Instructional Dimensions Study (Cooley & Leinhardt, 1980) focused on reading and mathematics instruction in the first-grade and third-grade compensatory education classrooms. This study revealed that achievement gain was associated with opportunity to learn as reflected in high amounts of time allocated to instruction, especially to instruction on the skills stressed in the tests. The degree to which such instruction was individualized was unrelated to achievement gain.

Sindelar, Smith, Harriman, Hale, and Wilson, (1984) observed reading instruction in elementary level classrooms for mildly retarded (EMR) students. They found that achievement gain was associated with the amount of classroom time devoted to teacher-directed instruction, and in particular with the frequency of teacher questioning (recitation).

Stallings et al. (1978) studied remedial reading instruction at the secondary level. Once again, quantity of instruction was the key correlate of achievement. Achievement gains were associated positively with time spent instructing small or large groups, reviewing or discussing assignments, having the students read aloud, praising their successes, and providing support and corrective feedback following their mistakes. Negative correlates included: teacher not interacting with the students; teacher getting organized rather than instructing; teacher offering students choice of activities; students working independently on silent reading or written assignments; time lost to outside intrusions or spent in social interaction; and frequency of disciplinary interactions. Within these general trends, the most successful teachers tended to use the methods that would be used in grade levels corresponding to these secondary students' existing reading levels. With students functioning at a primary reading level, small-group instruction that began with development of vocabulary and concepts and then proceeded to oral reading interspersed with questions to develop and check comprehension were typical. These were similar to the kinds of lessons that occur in beginning reading instruction, although with more emphasis on comprehension than word attack skills. With students functioning at higher reading levels, the teachers typically stressed more silent reading and written assignments, but still instructed the students actively and monitored their seatwork closely.

Crawford (1983) studied instruction in elementary level compensatory education for Title I students. As noted earlier, he found that the teachers were able to successfully implement individualized instruction and to pace students more briskly through curricula in these special classes with small student-teacher ratios. In all other respects, however, the findings paralleled those from regular settings. Across grade level and

subject matter, achievement gain was associated with allocation of high percentages of available time to academic activities, good monitoring and other classroom management techniques that maximized task engagement and minimized transition time and interruptions, and active instruction of the students.

Larrivee (1985) did not study instruction in special settings but did observe instruction of mainstreamed students in regular classroom settings during reading and language arts instruction in elementary classrooms. Relationships between teacher behavior and achievement gain by the mainstreamed students paralleled the findings for students in general. Achievement gains were positively associated with efficient use of time, supportive response to low-ability students, and high frequency of positive feedback to student performance, and were negatively associated with frequency of interventions concerning misconduct, time spent off task, and time spent in transitions.

In general, research in both regular and special settings suggests that the same aspects of the whole-class instruction/recitation/seatwork approach that are associated with achievement gain for students in general are also associated with achievement gain for students likely to qualify for Chapter 1 programs, but with two qualifications. First, because Chapter 1 students tend to be low in socioeconomic status and correlated cognitive ability and classroom affect factors, they appear to need even more active instruction and close supervision from their teachers than ordinary students do, and in particular they appear to need more focused, structured, and redundant teaching and more personalized and supportive interactions (but within the context of high expectations and an academic focus). Second, when assigned to special settings featuring small classes and availability of teacher aides, these students can be paced through curriculum more rapidly and can be taught using individualized materials and instructional methods that are not feasible under more typical classroom conditions.

## Other Relevant Research

So far, the presentation has been confined to studies that would typically be classified as "school effects" research or "teacher effects" research. A few other types of studies should be mentioned briefly before concluding the discussion.

Conceptual Change Teaching

Recent research in mathematics and science instruction has indicated that in addition to organizing and structuring information effectively, it sometimes may be necessary to plan instruction so as to surface and confront students' prior misconceptions about the content that may persist and distort their learning if not eliminated. This research is based on the fact that instruction does not involve infusing information into a vacuum, but instead involves inducing change in students' existing conceptions. Typically, students possess prior information and conceptions relating to the content to be taught (some of which will be misinformation or misconceptions), and the new learning will be filtered through this prior knowledge for good or ill. Effective instruction will connect the new learning with the existing prior knowledge, both by taking advantage of accurate prior knowledge as a basis for anchoring the new material to what the student already knows, and by clearing up misinformation and attacking misconceptions to make sure that they do not persist and cause the student to acquire a mistaken or distorted version of the truth.

Anderson and Smith (in press) review work by themselves and others on conceptual change teaching (focusing on science instruction). Their review suggests that neither curriculum writers nor teachers typically are very aware of common misconceptions that students are likely to harbor about particular content, so that the instruction that they provide not only fails to confront these misconceptions directly but often is presented in terms sufficiently general or imprecise to allow the students to interpret the new input as consistent with their existing misconceptions, and to distort it accordingly.

Anderson and Smith have shown that teachers can succeed in surfacing and eliminating such misconceptions if given better materials and training. The materials explain the content in more explicit and detailed terms and confront student misconceptions directly, and the teacher training acquaints teachers with general principles of conceptual change teaching and with techniques for surfacing students' misconceptions (in particular, asking them to explain their answers in order to explore the thinking that lies behind them). Such training appears to be important for teachers of mathematics and science, as well as for any teachers who are presenting content that is often misunderstood or distorted because it conflicts with common but erroneous preconceptions that students acquire through everyday experience.

Teaching Cognitive Strategies

Research on instruction in reading comprehension, mathematical problem solving, and various learning and study skills is showing that it is not enough merely to briefly explain and model such skills and then allow the students to practice them; in order to understand these skills comprehensively and be able to use them in their own learning, students need explicit, detailed explanations and cognitive modeling of strategy implementation that not only demonstrates relevant actions but includes verbalization of the information processing, decision-making, and other self-talk that guides these actions. Furthermore, the modeling should not only illustrate application of the cognitive strategies involved, but should illustrate the metacognitive awareness that should occur during strategy implementation (monitoring of one's comprehension of the content as one reads along; monitoring the decisions made and the reasoning behind them when attempting to solve problems) and the affective and cognitive responses involved in responding effectively when things do not go smoothly (staying calm and oriented toward coping rather than becoming anxious or frustrated; back-tracking, looking up definitions, or searching for context clues when confronted with a word that one does not understand; double checking one's logic and computations or searching for another strategy when one's strategy for solving a mathematical or scientific problem has not succeeded).

This is not the place for a detailed discussion of strategy training research (for general reviews see Good & Brophy, 1968a and Weinstein & Mayer, 1985, and for specific applications see Bereiter & Bird, 1985; Darch, Carnine, & Gersten, 1984; Duffy et al., in press; Palincsar & Brown, 1984; Paris, Lipson, & Wixson, 1983). The work is mentioned briefly here primarily to make two points.

First, Chapter 1 students are among those most likely to need heavy doses of strategy training in addition to more traditional instruction in academic content and skills. Research indicates that the brightest students tend to develop well functioning cognitive strategies and metacognitive awareness and monitoring skills largely on their own, so that they tend not to need or benefit much from strategy training. Low achievers, however, usually do not spontaneously develop these cognitive and metacognitive skills to high levels of functioning efficiency, so they are unlikely to reach such levels unless taught systematically. It is too early to tell yet just how much can be accomplished through strategy training with low achievers, but there are important theoretical reasons for believing that such training might have great benefit, not only for equipping these students with particular strategies to use in particular situations, but possibly also for application to a broader range of learning situations. Students with well

developed cognitive and metacognitive learning skills tend to approach learning tasks systematically, translate what they are learning into their own words and retain it in an organized way, and respond to confusion with redoubled learning efforts. In contrast, students with poorly developed cognitive and metacognitive learning skills, even if equally motivated, are likely to learn less and to remember less of what they do learn originally because they rely mostly on rote memorizing and other inefficient learning skills, fail to organize what they are learning for retention as a meaningful body of knowledge, and tend to skip over what they cannot understand or simply give up if they become frustrated.

A second point worth noting is that cognitive modeling is a presently underused but potentially very powerful way to instruct children in cognitive skills. The combination of modeling with verbalized self-instruction is a powerful instructional technique, especially for teaching complex processes that are guided by covert self-talk that remains hidden from the learners unless the teacher shares it with them. Students will not learn much from hearing a teacher identify the main ideas in a series of paragraphs or watching the teacher solve mathematics problems on the board if these "demonstrations" do not include verbalization of the thinking that guides the observable actions. When teachers do share this thinking, however, students not only can understand what the teacher is doing and why he or she is doing it, but can learn the general approach used to solve the problem and then apply it later when working on their own. The latter advantage makes modeling combined with verbalized self-instruction more effective than traditional lecture/demonstration methods for most instructional purposes. This is because the modeling provides the students with an integrated, within-context demonstration of how to approach and solve the problem, delivered in first person (self-talk) language. This is easier for them to retain and use than general information presented in third person language or even a set of instructions presented in second person language ("First you do this, then you do this..."). The latter forms of instruction must first be internalized and then translated into first person language to be used to guide behavior. Cognitive modeling eliminates the need for such translation, a feature that makes it especially desirable for teaching Chapter 1 students.

Mastery Learning

In theory, mastery learning approaches should be especially useful with Chapter 1 students because they were developed with low achievers in mind. According to Anderson (1985), mastery learning programs contain the following six components: (1) clearly specified learning objectives; (2) short, highly valid assessment procedures; (3) preset mastery performance standards; (4) a sequence of learning units, each composed of an integral set of facts, content, principles, and skills; (5) provision of feedback about learning progress to students; and (6) provision of additional time and help to correct specified errors and misunderstandings of students who are failing to achieve the preset mastery learning standards.

The heart of mastery learning is the cycle of teaching, testing, reteaching, and retesting. In theory, the provision of extra time and instruction to slower learners should have two important effects: (1) it will enable 80 percent of the students to reach levels of mastery commonly achieved by only 20 percent of the students under traditional methods; and (2) by insuring mastery of the earlier objectives in a curriculum sequence, the mastery learning approach will make it easier for slower learners to master the later objectives, and to do so more quickly, so that ultimately, the extra time taken earlier in the sequence will be recouped later in the sequence.

Early forms of mastery learning took the form of individualized tutoring, but later, Block and others (Block & Anderson, 1975; Block & Burns, 1976) adapted the approach for use by elementary and secondary school teachers in tandem with, rather than instead of, more traditional group-based instruction. At present, most mastery learning programs in the schools feature group-based rather than individualized instruction (Levine, 1985).

Research on mastery learning approaches indicates that achievement levels are higher in mastery classes, and that in particular, a much higher percentage of students master content believed to be basic (Block & Burns, 1976; Guskey & Gates, 1985; Walberg, 1984). However, these findings are limited and misleading in several respects. First, considerable additional learning time is required to achieve the reported gains in mastery of the material. Arrangements must be made to provide corrective instruction to slower learners before and after school, or more typically, to provide this corrective instruction during class time and thus hold back the faster learners while the teacher works with the slower learners. If differences in time taken to produce mastery are taken into account, there appears to be little or no advantage to mastery learning at all.

Another problem is that the research does not support the key assumption that taking time to insure mastery of earlier objectives will reduce the time that students need to learn later objectives (Arlin, 1984; Slavin & Karweit, 1984). Thus, it appears that instead of really solving the dilemma of having to choose between fixing time allotments and accepting individual differences in mastery levels or fixing mastery levels and accepting individual differences in time to learn, the mastery approach merely substitutes the second choice for the first.

A third problem in interpreting research on mastery learning is that the findings are extremely variable, and unfortunately, results tend to be more impressive for brief studies (lasting a week or less) involving instruction in content not normally taught at school than they are for studies of instruction in basic school subjects assessed over significant time periods (Guskey & Gates, 1985). Furthermore, although mastery learning approaches were developed with low achievers in mind, they appear to be especially difficult to implement in inner-city schools populated largely by low achievers. In part, this is because these schools tend to have high student-teacher ratios, high rates of absenteeism and transiency, high enrollments in pullout instructional programs, fewer instructional materials, and less time for groups of teachers to coordinate planning (Jones & Spady, 1985). However, it is also true that the corrective sequences in mastery learning are designed to correct relatively minor errors or misunderstandings, whereas students in inner-city schools may have a great many serious and idiosyncratic problems that need more individualized attention (Slavin & Karweit, 1984). In any case, group-based mastery learning approaches appear to be both especially difficult to implement in inner-city schools and ill-suited to the needs of inner-city students.

Chicago's experience with mastery learning approaches illustrates the difficulties involved in implementing the mastery learning philosophy in practice. With strong support from central administration, the Chicago public schools committed themselves to a mastery learning approach to elementary level reading instruction in the early 1980s. The program was entitled Chicago Mastery Learning Reading (CMLR; Jones, Friedman, Tinzmann, & Cox, 1985). The CMLR developers planned the program as a group-based approach and trained teachers in group-based mastery methods. Furthermore, they developed curriculum materials specifically designed for use with this approach, including two sets of tests to allow for both formative and summative assessment of student mastery levels. The materials and recommended instructional methods were developed with emphasis on the latest thinking in instructional design and delivery, and with emphasis on avoiding some of the

problems that have appeared in earlier programs (lack of sufficient integration of subskills, excessive emphasis on testing and record keeping, concentration on lower-order objectives to the exclusion of higher-order objectives). In fact, the CMLR curriculum materials are now being used in many school systems.

Yet, with all of this going for it, CMLR did not succeed. Comparisons with traditionally taught classes revealed no differences or only very slight advantages to CMLR classes. Worse, initial enthusiasm about CMLR waned and was replaced with complaints about the curriculum materials and about difficulties in implementing and managing the program. After a change in central administration, the Chicago schools dropped CMLR in 1985.

In conclusion, available research does not support the notion of wholesale replacement of traditional instruction with mastery learning approaches in typical classrooms. However, there do appear to be potential benefits in attempting to implement at least some aspects of the mastery learning philosophy. Extra time and instruction for low achievers will enable them to master more content than they would otherwise, and this additional mastery is likely to bring motivational benefits as well.

However, the emphasis should be on maximizing each individual student's achievement progress rather than on reducing the variance in achievement levels. Because it appears that the mastery approach cannot succeed in reducing the time that slower learners need to learn (relative to the time that fast learners need), it will be possible to reduce variance in achievement progress only by deliberately holding back the faster learners. This is not to suggest that teachers should continually push faster learners to higher curriculum levels instead of allowing them to engage in enrichment activities or other alternatives to acceleration through the curriculum. However, the activities planned for faster learners should be selected for sound pedagogical reasons, and not as mere time fillers designed to slow their progress in order to pursue the (inappropriate) goal of reducing individual differences in achievement levels. A sensible compromise here seems to be to identify those learning objectives that seem most essential and see that all students master these objectives, while tolerating more variable performance on objectives considered less essential. Teachers can supplement the basic curriculum with enrichment opportunities, individualized learning packages, or learning centers that high achievers can use individually or in groups during times when teachers are busy teaching low achievers.

## Individualized/Adaptive Instruction

Attempts to make schooling more effective by fitting instruction to students' individual needs have traditionally been described as individualized instruction approaches, although the terms "adaptive instruction" or "adaptive education" have been popularized in recent years (Wang & Walberg, 1985). All of these terms are difficult to discuss because they lack precise meaning and have been applied to programs that differ from one another in important ways (Berliner, 1985). Wang and Lindvall (1984) list the following as distinguishing features of adaptive education approaches: (1) instruction based on the assessed capabilities of each student; (2) materials and procedures that permit each student to progress at a pace suited to his or her abilities and interests; (3) periodic evaluations that inform the student concerning mastery; (4) student assumption of responsibility for diagnosing present needs and abilities, planning learning activities, and evaluating mastery; (5) alternative activities and materials for aiding student acquisition of essential academic skills and content; (6) student choice in selecting educational goals, outcomes, and activities; and (7) students' assistance of one another in pursuing individual goals and cooperation in achieving group goals. Few individualized instruction or adaptive education programs have all seven of these features, but most have several of them.

Individualized learning systems became popularized in the 1960s and 1970s: Individually Prescribed Instruction (IPI), the Primary Education Project (PEP), the Program for Learning in Accordance with Need (PLAN), and Individually Guided Education (IGE). Comparisons of such individualized programs with traditional instruction typically report either no differences or very minor differences, with more variation within than between the two types of program (Bangert, Kulik, & Kulik, 1983; Horak, 1981). More recent evaluations of programs classified as "adaptive education" have shown more positive results (Wang & Lindvall, 1984; Waxman, Wang, Anderson, & Walberg, 1985) although the majority of the studies reviewed were small ones involving less than 150 students and the best results appear to be associated with frequent assessment, student self-management and choice, and cooperative learning arrangements rather than with reliance on individualized progress through programmed materials.

Quality of implementation has often been a problem with individualized approaches. Reviewers often report good results in classrooms where programs were considered to be well implemented, but also report that only a minority of classrooms were so classified. Evaluations of the IGE program, for example, found that although IGE failed to bring about significant improvements in achievement outcomes, the problem

was not so much that IGE was tried and found wanting as that IGE was never truly implemented in the majority of schools that presumably adopted the program. Most "IGE schools" never really did individualized instructional planning based on assessment data, and most did not implement multi-age grouping or arrange for continuous regrouping of students in response to current instructional needs, as program guidelines call for (Popkewitz, Tabachnick, & Wehlage, 1982; Romberg, 1985).

Other individualized programs experienced similar implementation problems. It appears that these problems were due mostly to inherent difficulties in individualizing instruction in typical school settings rather than to irrational teacher resistance or similar causes. One problem was that these programs usually required extra staff and supplies that were not typically found in ordinary schools. Another was reliance on individual materials that stressed isolated low-level skills and required students to learn on their own rather than in groups or with the teacher. As a result, oral reading was sacrificed in favor of worksheet activities concentrated on phonics subskills, creative writing was sacrificed for practice in spelling and punctuation, work with concrete manipulatives in mathematics was sacrificed for computational exercises, and science and social studies virtually disappeared (Kepler & Randall, 1977).

Slavin (1984) suggests that, for any kind of instruction to be effective, four conditions must be satisfied: (1) the instruction must be high in quality; (2) the instruction must be appropriate to the students' levels; (3) the students must be motivated to work on the tasks; and (4) the students must have adequate time to learn. Slavin argues that the individualized instructional programs of the 1960s and 1970s failed to work effectively in practice because they concentrated on increasing the appropriateness of instruction but did not address the other three essential conditions. Quality of instruction was reduced because the students were not taught directly by the teacher. Students were not adequately motivated because individualized instruction was often boring and seldom offered incentives for moving through the curriculum. Finally, much classroom time was spent on procedural matters (passing out materials, waiting for the teacher to check work, taking tests), to the point that time for learning was actually reduced in many cases.

Arlin (1982), Carlson (1982), Everhart (1983), and Jones et al. (1985) also provide discussion and examples of the difficulties that teachers had in implementing individualized instructional programs and the ways that what students actually experienced in the classroom fell far short of what the programs's developers had envisioned. Some of these problems are remediable: Developers can supply more and better

materials, can offer a more balanced and integrative curriculum rather than overstress low-level isolated skills, and can supply multi-media components that reduce the students' needs to learn exclusively through reading. The root problem, however, seems to be the student-teacher ratio. No individualized program is likely to work effectively if it depends on the teacher to simultaneously provide individualized instruction to all of the students in the class. So, unless they are implemented in very small classes or significant help from aides or other adult resources is available, adaptive education programs will have to rely on other strategies.

Two recently developed individualized instruction/adaptive educational programs have achieved better results than the individualized instructional programs of the 1960s and 1970s. These are the Adaptive Learning Environment Model (ALEM) developed at the University of Pittsburgh and the Team Assisted Individualization (TAI) model developed at the Johns Hopkins University.

ALEM combines aspects of prescriptive instruction in basic skills with aspects of informal or open education designed to generate independent inquiry and peer cooperation (Wang, Gennari, & Waxman, 1985). It includes five major components: (1) a basic skills curriculum consisting of highly structured and hierarchically organized learning activities, along with a variety of more open-ended exploratory learning activities aimed at accommodating individual students' learning needs and interests; (2) a system for managing curricular materials and the use of teachers' and students' time; (3) a family involvement component designed to increase communication and integrate school and home learning experiences; (4) a flexible grouping and instructional team system designed to increase flexibility in use of teacher and student time, talents, and resources; and (5) a data-based staff development program that provides written plans and procedures to assist school staffs in initiating and monitoring program implementation.

ALEM is complex: it requires aides, computerized record keeping, and other specialized resources and procedures. Given these complexities and the need for frequent planning meetings and changes in physical space use and type of equipment included in classrooms, it might have been expected that ALEM would prove just as difficult to implement as most of its predecessors. However, data from over 100 ALEM-sponsored Project Follow Through classrooms show that the majority of teachers implemented the program to a very high degree of fidelity with its guidelines. There appear to be at least three reasons for this successful implementation. First, the program's developers placed great stress on implementation and developed materials and methods designed to accomplish it effectively. Second, rather than relying exclusively on

materials-based individualized instruction, the program calls for introducing new content and skills through whole-class or small-group instruction before the students work individually. This makes for a higher quality of instruction and a somewhat easier teacher adjustment than switching to a totally individualized program would involve. Third, ALEM contains program elements designed specifically to orient students toward working independently with materials and working cooperatively with peers in small groups. The students are taught how to budget their time, select goals and plan methods of attaining them, monitor their understanding as they read and make responses, check their answers for accuracy, and so on.

So far, ALEM has shown that a complex adaptive education program can be implemented with high fidelity in a broad range of classrooms, and that even primary grade students can be taught to assume a great deal of responsibility for managing their own learning. ALEM requires extra resources and time devoted to planning, management, and record keeping, however, so that widespread adoption in public schools seems unlikely unless further experience with the program indicates that it offers sizeable advantages over traditional instruction. Early evaluation data on ALEM are promising in that student achievement in ALEM classrooms compares favorably with national norms and with norms projected for students in the Follow Through program, although it remains to be seen whether ALEM will produce significant advantages in student outcome beyond those produced through traditional methods.

A second recently developed innovation that avoids many of the difficulties traditionally associated with individualized instruction is Team Assisted Individualization (TAI). TAI was developed for mathematics instruction in grades 3-6 (Slavin, 1985). It combines active instruction (to small, homogeneously formed groups) by the teacher, follow-up practice using programmed curriculum materials, and a student team learning approach to seatwork management. The program was developed with the following criteria in mind: (1) the teacher would be minimally involved in routine management and checking of work; (2) the teacher would spend at least half of the period teaching students in small groups (rather than working with individuals or doing management tasks); (3) program operation would be simple enough for students in grades three and up to manage; (4) students would be motivated to proceed rapidly and accurately through the materials, and would not be able to do so by cheating or finding shortcuts; (5) mastery checks would be provided so that students would rarely waste time on material they had already mastered or run into serious difficulties requiring teacher help, and alternative instructional activities and parallel tests would be provided at each mastery check point; (6) students would be able to check one another's work (even when the checker was not as far

along in the curriculum as the student being checked; (7) the program would be simple for teachers and students to learn, inexpensive, and flexible, and it would not require aides or team teaching; and (8) by having students work in cooperative, equal-status groups, the program would establish conditions for positive attitudes toward mainstreamed, academically handicapped students and among students of different racial or ethnic backgrounds.

TAI has achieved positive results in several field tests. The students have proven capable of responsibly handling the checking, self-routing, recording, and monitoring functions built into the program, and they enjoy the team reward system. Most teachers also enjoy the program and find it workable, although training procedures had to be revised to correct an early tendency for the teachers to spend too much time working with individuals and not enough with small groups. The curriculum materials also appear to be effective. Comparisons of TAI with traditional methods or other special methods have yielded higher scores for the TAI groups in every comparison. The differences are typically significant for computation tests but not significant for concept and application tests. TAI programs also showed more positive effects on social acceptance and behavior of academically handicapped mainstreamed students and improved attitudes and friendships among Black and White students.

On the whole, TAI has produced the most impressive results of all of the adaptive education programs, even though it is easier to implement than most and does not require additional instructional personnel or significant additional resources. Slavin (1985) cautions, however, that the program is difficult to implement in inner-city classrooms containing high concentrations of students with serious reading or behavior problems where neither teachers nor students may be prepared to handle the increased responsibility and autonomy that students assume in TAI classes.

Computerized Instruction

In theory, computerized instruction has the potential for avoiding the problems associated with individualized learning systems developed in the 1960s and 1970s, especially now that microcomputers are becoming more available in classrooms. Assuming comparable instructional content, computerized instruction offers several potential advantages over conventional textbooks or programmed learning materials.

First, it brings novelty or at least variety to the students' school experiences, and thus is likely to be experienced as more enjoyable than conventional seatwork. Second, especially if combined with videodisc technology, it can

incorporate animation, time-lapsed photography, and other audio-visual techniques for communicating information and demonstrating processes in ways that are not possible through conventional print materials. Third, it can allow students to respond more actively and in more varied ways than they can respond to conventional seatwork, and can provide them with immediate feedback following their responses. Fourth, computers can be programmed to keep track of students' responses, thus accumulating records for teachers to use in monitoring progress and planning remedial instruction. Fifth, it may be possible to build the capacity for diagnosis and prescription right into the program itself, so that students are automatically routed to skip parts that they do not need and to work through remedial sequences when they have not been able to achieve mastery by working through the regular program. Sixth, programs may provide not only opportunities to practice and get feedback, but tutorial instruction and friendly encouragement similar to what the student might receive from a skilled and sensitive tutor. Finally, computerized instruction can provide opportunities for higher-level problem solving and simulation activities of the kind seldom seen in conventional seatwork or programmed individualized instruction. To the extent that these potential advantages can be achieved at reasonable cost, transferring significant instructional functions from the teacher to the computer might be a feasible way of implementing adaptive education principles in typical school settings.

However, it remains to be seen whether computerized instruction's theoretical potential can become a practical reality. Reviewers interested in computer applications to ordinary classroom settings have identified several important limitations on the computer's present and potential impact (Amarel, 1983; Becker, 1982; Brophy & Hannon, 1985; Educational Products Information Exchange, 1985; Lesgold, 1983; Sloan, 1985).

One major problem is availability of appropriate software. The majority of programs available even today are nothing more than electronic versions of traditional workbooks providing drill and practice on low-level skills. Once the novelty of using the computer wears off, a steady diet of these programs is likely to be just as boring as a steady diet of comparable workbook exercises, and even less efficient (students with a basic grasp of the concepts and skills involved can move quickly through workbook pages when they know how to respond and are sure that their answers are correct, but in working through a computerized version of the same exercise, they would have to take time to type in each response and then wait for confirmation before the program would allow them to go on to the next item). Also, most programs are short (requiring only an hour or two at the most to complete) modules designed to

provide drill and practice on just one or a small set of related skills. They are not systematically sequenced and integrated curricula designed to provide a full semester or year of instruction in a conventionally taught elementary or secondary level course. Thus, teachers may have difficulty finding good software, and even when they do, they are likely to be unclear about when or how to use the program because it will not be integrated with the officially adopted curriculum objectives and materials that drive their instruction. Consequently, most teachers tend to use computerized instruction just for enrichment with faster students or remedial drill and practice with slower students, even if they are not hampered by the problems discussed below.

Limited access to computers creates additional feasibility problems. Cost considerations (including future projections) are such that school systems are unlikely to supply typical classrooms with more than one or two microcomputers (except for classrooms equipped for instruction in computer programming). A great many more computers would be needed to implement programs that call for students to spend significant time at the computer. For example, survey data indicate that even in classrooms containing eight computers, students may spend as much as three-fourths of their time waiting for a turn at the computer (Center for Social Organization of Schools, 1984). This problem can be alleviated somewhat by having students work in small groups with a single microcomputer, although almost all of the presently available software was designed for individuals, and adaptation for use by groups may sometimes be difficult.

A related problem is the trade-off between computer cost and capacity. Many of the most interesting instructional possibilities in computerized instruction require videodisc technology in addition to microcomputers, and programs that make possible the most desirable and sophisticated advances over ordinary programmed instruction (interactive simulation exercises and games; tutorial programs that provide diagnosis and corrective instruction in addition to mere drill and practice with feedback; provision for automatic record keeping and preparation of diagnostic performance summaries) require mainframe computers that are vastly more powerful and expensive than microcomputers.

Therefore, in the near future at least, teachers' options for integrating computerized instruction into their classrooms would be limited to drill and practice programs and educational games prepared for use by individual students on minicomputers (some of which may be adaptable for use by small groups of students). Thus, computerized instruction is not yet a solution to the practical problem involved in implementing individualized instruction in the typical classroom. On the

other hand, it offers opportunities worth exploiting for teachers who have access to microcomputers. An evaluation of a computerized drill and practice curriculum tested in the Los Angeles schools (Ragosta, Holland, & Jamison, 1981) found that even though the students often complained of boredom, the program had a positive impact on mathematical computation skills. Findings were mixed for mathematical concepts, and were less positive in language and reading than in mathematics.

Tucker (1981) provides useful advice on how schools can systematically prepare to make intelligent decisions about purchasing and using microcomputers. Lathrop (1982) provides guidelines and a useful bibliography for evaluating the quality of software. Finally, the Educational Products Information Exchange (1985) provides descriptions and critical reviews of hundreds of software products being sold for use in schools.

## Conclusions

The last 15 years have finally produced an orderly knowledge base linking teacher behavior to student achievement. As would be expected given the nature and complexity of teaching, this knowledge base consists of a large number of low to moderate correlations rather than a small number of very high correlations. This fits well with the common sense notion that effective teaching involves mastery and orchestration of a large number of teaching skills suited to particular situations rather than continued performance of a few presumably generic "effective teaching behaviors."

If applied with proper attention to its limits, this knowledge base should help improve teacher education and teaching practice. However, several important limitations and qualifications need to be kept in mind. First, as noted previously, process-outcome data (or any scientific data) do not translate directly into policy decisions. Such data can identify efficient methods for accomplishing given goals, but policy makers must set priorities among potential goals on the basis of values, not science.

Second, achievement gain was the only outcome considered here in detail. Fortunately, it appears that most of the teacher behaviors associated with achievement gain (and especially the supportive and encouraging teacher behaviors associated in particular with achievement gain by low achievers) will also be supportive of progress toward affective goals, at least up to a point. However, it should be recognized that it is possible to optimize progress toward several different goals simultaneously only to some degree, so that

eventually, further progress toward one goal will come at the expense of progress toward others.

Third, causal linkages between teacher behavior and student achievement gain are not always well established, and even when they are, analysis and interpretation are needed to identify prescriptions for practice. For example, a positive correlation between a teacher behavior and student achievement does not necessarily indicate that the behavior should be maximized (even within the observed range, let alone the theoretical range). Thus, it would be inappropriate to conclude that teachers should always wait at least three seconds for a response to a question, should never criticize students, or should never schedule independent seatwork. To develop sensible recommendations, it is necessary to consider the means and ranges of variation in observed teacher behaviors, along with the contexts within which the behaviors occur and the patterns of relationship with other teacher behaviors and with student behaviors. In what contexts is this teacher behavior an option? What other options are available in the same contexts? When is this behavior the option of choice, and why? Answering such questions requires detailed knowledge about process-process as well as process-outcome relationships (and more generally, a familiarity with classrooms and how they work). They are not well addressed, let alone answered, through simple-minded box scores and meta-analyses.

It also should be recognized that there may be different but functionally equivalent paths to these same achievement outcomes. For example, it may make no important difference whether the three main points of a presentation are summarized at the beginning or the end, so long as they are summarized, or whether a mathematics computation review is done with flash cards during a lesson or through a seatwork assignment afterwards. Such complexities have rarely even been considered, let alone investigated systematically, and this is one reason why data linking teacher behavior to student achievement should not be used in rigid ways for teacher evaluation or accountability purposes. If teachers are to be evaluated according to the achievement gains they produce, these achievement gains should be measured directly. Teachers should not be penalized for failing to follow particular behavioral prescriptions if they produce as much achievement as other teachers who follow such prescriptions.

Most process-outcome findings were based on natural variation observed in traditionally taught classrooms, so that generalization of these data is limited to such classrooms. Also, prescriptions for application should remain within the ranges of behavior observed. Simple-minded extrapolations beyond these ranges (such as, if 15 minutes of homework per

night is good, two hours per night would be eight times better) are not supported by the data and are probably counterproductive. Unfortunately, such extrapolations are common in certain school improvement programs.

Finally, most findings must be qualified by grade level, type of objective, type of student, and other context factors. Even within context, it seems likely that most relationships between quantity (as opposed to quality) measures of teacher behavior and measures of student outcome will be ultimately curvilinear, so that all recommendations based on such relationships will need to have boundary conditions specified. Too much of even a generally good thing is still too much.

Despite the need for limitations and qualifications, two common themes cut across the findings. One is that academic learning is influenced by the amount of time that students spend engaged in appropriate academic activities. A second is that the students learn more efficiently when their teachers instruct them actively by structuring new information and helping them relate it to what they already know, and then monitoring their performance and providing corrective feedback through recitation, drill, practice, and application activities. For a time, these generalizations appeared to be confined to the early grades or to instruction in basic rather than more advanced skills. However, it now appears that they apply to instruction in any body of knowledge or set of skills that has been sufficiently well organized and analyzed so that it can be presented systematically and then practiced or applied during activities that call for student performance that can be evaluated for quality and (where incorrect or imperfect) given corrective feedback. This certainly includes aspects of reading comprehension and mathematics problem solving in addition to word attack and mathematics computation. Even for higher-level complex learning objectives, guidance through planned sequences of experience is likely to be more effective than unsystematic trial and error.

The key to maximizing achievement gains of Chapter 1 students (or any students, for that matter) appears to be maximizing the time that they spend being actively instructed by their teachers or supervised as they work on assignments (assuming that both the instruction and the assignments are pitched at an appropriate level of difficulty and otherwise well suited to the students' current needs). The traditional whole-class instruction/recitation/seatwork approach maximizes the time that students spend being directly taught or supervised by the teacher, but may not provide instruction or assignments that are well matched to the students' individual needs if the class is heterogeneous. Small-group instruction allows for more personalized and somewhat more individualized instruction during small-group lessons, but requires students

to spend a great deal of time working independently without close teacher supervision. Individualized instruction does the best job of matching assignments to individual needs, but the instruction is of lower quality because it comes mostly from the materials rather than the teacher, and students spend most of their time working independently without close teacher supervision (except in classes with small student-teacher ratios).

Any one of these approaches (or combinations of them) can be made to work under certain circumstances, depending on class size, availability of aides, availability of materials and assignments for differentiated instruction, the teacher's planning and classroom management skills, and other factors. In typical classrooms, however, traditional approaches are both easier to plan and manage and likely to offer a more attractive mixture of compromises and trade-offs than any of the feasible alternatives. Thus, most teachers are likely to opt for whole-class instruction (small-group instruction for beginning reading) featuring teacher explanation of content or demonstration of skills followed by recitation, drill, or discussion activities, followed by seatwork and homework assignments designed to provide practice and application opportunities. Within this whole-class approach, teachers can provide a degree of individualization by spending more time with low achievers, introducing a degree of differentiation in assignments and grading criteria, planning special projects or learning centers to provide enrichment opportunities for faster learners and remedial instruction and assignments for slower learners designed to see that they master basic concepts and skills, and (where appropriate) including cooperative learning activities in addition to independent seatwork. If an aide is available and trained to supervise seatwork effectively while the teacher instructs small groups, the teacher can schedule more small-group instruction and thus differentiate instruction more systematically. If the class is small enough, individualized instruction and assignments may become feasible. Ideally, however: (1) the teacher should carry the content to the students rather than depend on curriculum materials to do so; (2) the teacher should actively circulate and supervise progress during seatwork times; and (3) students who need help should be able to get it immediately.

Unless they are trained from the beginning in a particular program such as DISTAR (Englemann & Bruner, 1975) or ALEM, teachers should probably receive systematic training in the classroom organization, lesson presentation, and seatwork management skills involved in effective implementation of the traditional whole-class instruction/recitation/seatwork approach. At minimum, this will provide them with a "starter set" of instructional skills that are known to work in typical classroom settings and that, in combination, constitute a

systematic method of teaching that works reasonably well in its own right and that also forms a base from which the teacher can begin to phase in grouping, differentiated instruction, cooperative learning methods, and other adaptations. Resource books useful for accomplishing this are becoming available (for example, see Good and Brophy, 1984), and inservice training programs such as Teacher Expectations and Student Achievement (TESA), Madeline Hunter training, or the videotape program on effective teaching skills offered by the Association for Supervision and Curriculum Development cover many of the principles and skills reviewed here.

Ultimately, however, the most effective responses to the needs of Chapter 1 students (and to students in general, for that matter) will be the systematic development of comprehensive programs of curriculum and instruction that draw eclectically but planfully from the full range of available knowledge in devising effective methods of accomplishing specified goals. More information is badly needed about what constitutes effective instructional units (not just specific lessons or seatwork assignments), and about effective curriculum alignment and integration of program elements within and across subject matter. So far, discussions of curriculum issues tend to be confined to philosophical argument without enough empirical input or testing of assumptions, instructional design models (Reigeluth, 1983) have not given much consideration to instruction as it occurs in classrooms, and process-outcome research conducted in classrooms has concentrated mostly on quantity rather than quality of instruction and has not paid enough attention to curriculum objectives and to pedagogical issues specific to the content or skills being taught.

Some progress is being made, however. Process-outcome researchers are getting more sophisticated about curriculum and designing studies that are much more circumscribed and specific in terms of grade level, subject matter, and curriculum objectives. Also, program developers are beginning to pay attention to accumulated research findings. In contrast to the 1960s, when Project Follow Through encouraged developers to differentiate their programs from other programs, contemporary program developers are concentrating on quality and comprehensiveness rather than uniqueness, borrowing elements from eclective sources and weaving them into integrated approaches. The ALEM and TAI programs mentioned earlier are examples.

Another example is the Kamehameha Early Education Program (KEEP), a beginning reading program developed for socioeconomically disadvantaged children in Hawaii (Au et al., 1985). Among other things, the program includes intensive small-group instruction in reading to children grouped on the basis of criterion referenced test results, emphasis on maximizing students' attention to lessons and engagement in

assignments, instruction in phonics conducted within an emphasis on reading for meaning, instruction in reading comprehension strategies in addition to word attack skills, learning centers in which students work independently on activities that support the overall reading instruction program, and lesson participation rules that capitalize on native Hawaiian cultural traditions and minimize the degree to which school norms clash with these traditions. The program exemplifies the comprehensive and eclectic recommendations for effective reading instruction made by the authors of Becoming a Nation of Readers (Anderson, Hiebert, Scott, & Wilkinson, 1985), based on systematic review of the literature on curriculum and instruction (including classroom teaching) in reading. To the extent that the needs of Chapter 1 students can be met with existing school resources, it will be through development and revision of such comprehensive, research-based programs.

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